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SHAPING APPARATUS WITH INTERCHANGEABLE PLATES

The present invention relates to an apparatus intended to ensure shaping of a web made of a flexible material, such as in particular a web of cardboard, from shaping rolls provided with plates of which the format is variable and interchangeable.

It is known for example that, in the domain of rotary cutting-out, the cut-out rolls as well as their associated control pinions must be changed when it is desired to pass from one format to another. Now, most of the time, these rolls are machined in the mass, so that this operation of replacement is translated by a particularly high cost.

In order to reduce this cost, it has been proposed to produce cut-out rolls which are constituted by a support roll, on the surface of which is fixed an interchangeable plate which is provided with cut-out threads. Such a device allows a rapid exchange and is translated by a reduced cost when one passes from one plate to another. Such an exchange is thus effected without problem, as long as the cut-out format remains unchanged from one plate to the other.

However, when such is not the case, one is then obliged to change the support roll as well as its accessory drive means.

The present invention has for its object to overcome such a drawback by proposing a shaping apparatus provided with a regulating module making it possible to use plate support rolls of a constant diameter on which the user will fix, as a function of his needs, work plates of diverse format, without it being necessary for all that, when he will pass from one plate format to another plate format, to exchange the support roll and its drive means.

In other words, the present invention makes it possible for the user to exchange only the shaping plates in order to pass from a determined work

format to another format, within the limit, of course, of the peripheral length of the roll.

The present invention thus has for an object an apparatus for shaping a web made of a flexible material, comprising at least one feed roll adapted to deliver the web continuously in accordance with a law of given displacement and speed, a shaping roll associated with a counterpart roll adapted to shape the web over at least a part of its peripheral length, this shaping roll being constituted by a support roll on which at least one interchangeable shaping element is added, fixed on its outer surface, and which is animated by a movement of rotation in accordance with a law of given displacement and speed, characterized in that it comprises, between the feed roll and the shaping roll, a regulating module provided with take-off means adapted to control the displacement and the speed of the web upstream of the shaping roll and at least one mobile guide element adapted to exert on at least one buffer loop of the web formed between said rolls, a positive guiding of which the displacement is controlled in accordance with a determined law.

According to the invention, the law of displacement of the mobile element for guiding the web will preferably be a function of the law of displacement of the feed roll and of the law of displacement of the take-off means, itself a function of the law of displacement of the shaping roll.

The take-off means will preferably be constituted by at least one roll.

The take-off means may also be constituted by the mobile guide element, the latter being formed by a rotary roll around which the web winds; at least one rotary roll animated by a peripheral speed greater than that of the web being disposed between the shaping roll and the guide roll.

The guide element may be constituted by a rotary roll, or by a piece fixed in rotation, about which the web will wind. Particularly when the guide element

is constituted by an element fixed in rotation, it may be provided with means for blowing a gas adapted to create between itself and the web a cushion of gas.

The movement of displacement of the guide element may in particular be linear or circular.

When the displacement is linear, it may be obtained by a linear motor comprising primary and secondary poles mobile with respect to each other and means for controlling their relative movements, the guide element being fast with one of these poles. This linear displacement of the guide element may also be obtained by a system constituted by a connecting rod articulated at one of its ends on the latter and at its other end on a crank whose angular position will determine the linear function of the guide element.

When the displacement is circular, the guide element will be constituted by a guide roll arranged so that it is adapted, in the course of its displacement, to remain tangential to another roll, the web being admitted between these rolls and winding around the latter in order then to go in the direction of the shaping roll.

This other roll may be constituted by a regulating roll or equally well by the take-off roll.

In order in particular to minimize the forces of friction exerted on the web, the guide roll and the regulating roll may be servo-controlled by each other in rotation, so that their peripheral speeds are identical.

According to the invention, the circular displacement of the guide and regulating rolls may ensure controlling of position and of speed of the web upstream of the shaping roll. The apparatus may, furthermore, comprise, between the feed roll and the take-off roll, a system for controlling the tension of the web by which the feed roll may be servo-controlled, so as to ensure maintenance of the tension thereof at a constant value.

Finally, the apparatus may comprise means adapted to read a cyclic mark disposed on the web, to compare the position thereof with a position reference of the shaping roll and, as a function of this comparison, to modify the positioning of the web with respect to the shaping roll.

A form of embodiment of the present invention will be described hereinafter by way of non-limiting example, with reference to the accompanying drawing, in which:

Figure 1 is a schematic view of a cut-out apparatus disposed in a printing machine.

Figure 1a is a schematic view of a variant embodiment of the printing machine shown in Figure 1.

Figure 1b is a schematic view of a variant embodiment of a guide element used in the apparatus according to the invention.

Figures 2a and 2b are partial schematic views showing cut-out rolls in two respective positions, namely a first position corresponding to the end of the cut-out phase and a second position corresponding to the beginning of the cut-out phase.

Figure 3 is a schematic view of a variant embodiment of a shaping apparatus according to the invention.

Figure 4a is a diagram respectively representing the speed of feed of the web, the peripheral speed of the cut-out rolls, the speed of feed of this web directly upstream of the cut-out rolls, the speed of the roll of the regulating loop of the web, and this, on the one hand, during the cut-out phase and, on the other hand, during the end-of-cycle phase.

Figure 4b is a diagram respectively representing the positioning of the feed of the web, of the periphery of the cut-out rolls, of the feed of this web directly upstream of the cut-out rolls and of the roll of the regulating loop of the

web, and this, on the one hand, during the cut-out phase and, on the other hand, during the end-of-cycle phase.

Figure 5 is a diagram of the same type as that of Figure 4a in a form of embodiment of the present invention in which the speed of feed of the web to be cut out varies in the course of a cut-out cycle.

Figure 6 is an example of a variant application of the shaping apparatus according to the invention.

Figure 7 is a schematic view of a variant making it possible to constitute a regulating loop employed in an apparatus according to the invention.

Figures 8 and 10 are schematic views of two other variant embodiments of the apparatus shown in Figure 7.

Figure 9 is a schematic view of a variant embodiment of a mobile guide element according to the invention.

Figure 1 shows a shaping apparatus 1 of a printing machine, intended to effect a cut-out operation. This shaping apparatus is constituted by a cut-out roll 3 and its counterpart roll 3', which are animated by a movement of rotation at a peripheral speed V_c, between which a web of cardboard 2 to be cut out is admitted at a speed V_n, this web 2 being delivered by a feed roll 5 and its counterpart roll 5', at a peripheral speed V_e.

The cut-out roll 3 and its counterpart roll 3' are constituted by a support roll 3a on which a shaping plate, for example a cut-out plate 3b, is fixed. As a function of the work to be carried out, this cut-out plate 3b may be more or less long, so that it will occupy a more or less great part (p) of the total periphery P of the cut-out roll 3.

Under these conditions, it will be understood that, unless a considerable proportion of the web (equal to P-p/P) is wasted, it is necessary to provide that, as soon as the cut-out phase is ended, corresponding to the position of Figure 2a,

the web 2 be stopped while the cut-out roll 3 and its counterpart roll 3' determine their cycle of rotation (End-of-cycle phase). Moreover, for the subsequent cut-out operation to be able to run normally, it is also necessary that, at the moment of the beginning of the following cut-out, and during the whole cut-out operation, the speed V_n of the web 2 occurring between the cut-out rolls be the same as the peripheral speed of these latter, viz. V_c, this making it necessary to cause the web 2 to go back during the end of the cycle for shaping the cut-out rolls 3, in order then to return it forwards to communicate thereto the speed $V_n=V_c$ all along the cut-out.

It is for that purpose that a regulating module 7 has been disposed between the feed rolls 5 and the cut-out rolls 3. This regulating module makes it possible to produce a loop 8 forming "buffer" and allows that part of the web 2 located just upstream of the cut-out rolls 3 to stop, and even to move back, although the feed rolls 5, 5' continue to feed the web 2 at a speed V_e.

The regulating module 7 is constituted by a guide element, here constituted by a guide roll 9, around which the web 2 winds, and by a take-off roll 13 provided with a counterpart roll 13' between which the web 2 is engaged. Unlike the "buffer" bands of the prior state of the art, this band is thus guided positively, i.e. it is maintained by an element whose position is determined mechanically or electronically, so that the displacement of the guide roll 9 is servo-controlled by the movement of displacement of the loop 8 and more precisely by the length thereof, and not by an element whose position is determined by the band itself, as is the case, for example, when a pulley or a roll is in gravitational abutment on the base of the band. It has been ascertained that such an arrangement made it possible to attain much higher operational speeds. The guide roll 9 is mounted to rotate about its shaft 14 and the latter is supported by a carriage 15 adapted to effect a linear movement in a vertical direction

perpendicular to the horizontal direction of displacement of the web 2. The displacement of the carriage 15 may in particular be ensured by a linear motor, by a connecting rod/crank system, or by any other appropriate mechanism. In the present form of embodiment, the take-off roll 13 and the feed roll 5 are disposed in such a manner with respect to the guide roll 9 that the two web sections 2a located upstream and downstream of the latter are parallel. Figure 9 thus shows an example of a means for linear displacement of a guide element 9' with the aid of a system constituted by a connecting rod 10 articulated at one of its ends on this guide element 9' and at its end on a crank 12 whose angular position determines that of the guide element 9'.

Of course, the guide roll 9 may be fixed in rotation or, as shown in Figure 1b, it may be other than a rotating roll and may be formed by a fixed guide element 9', for example a semi-cylindrical one.

Figures 4a and 4b respectively show, during a cycle of rotation of the cut-out rolls 3, on the one hand, the diagram of the speeds, and, on the other hand, the diagram of the relative positions of the feed rolls 5 (viz. V_e, X_e), of the cut-out rolls 3 (viz. V_c, X_c) of the web directly upstream of the cut-out rolls 3 (viz. V_n, X_n) and of the guide roll 9 (viz. V_t, X_t) and this for a plate element 3a whose length p represents 3/5 of the periphery P of the cut-out rolls 3 (viz. p/P=0.6).

It is thus ascertained that the position X_t and the speed of vertical displacement V_t of the guide roll 9 are respectively a function of the positions X_e, X_n, on the one hand, and of the speeds V_e, V_n on the other hand, viz.

$X_t = f(X_e, X_n)$

$V_t = f(V_e, V_n)$

In the case of the form of embodiment shown in Figure 1, and since the sections 2a of the web 2 located upstream and downstream of the guide roll 9 are parallel, the following will be had:

$X_t = (X_e - X_n) / 2$

$V_t = (V_e - V_n) / 2$

and the carriage 15 will be animated by a movement which will be a function of this law of displacement X_t and of speed V_t.

The present invention makes it possible to control the loop 8 which, due to the aerodynamic phenomena and the inertias, is capable of disturbing, particularly at high speed, the advance of the web 2 and its positioning, both in the longitudinal and transverse direction, under the shaping plate.

Of course, according to the invention, the loop 8 may take several configurations as a function of needs. For example, in the variant embodiment shown partially in Figure 1a, the sections 2a of the web 2 located upstream and downstream of the guide roll 9 are no longer parallel and their respective inclinations with respect to the vertical are different. It will be understood that, in such a configuration, the laws of displacement X_t and of speed V_t of the guide roll 9 will, of course, be different from those of the form of embodiment according to Figure 1.

In another form of embodiment of the present invention, which is shown in Figure 3, the regulating loop 8 is located above the web 2 and the guide roll 9 is located in the upper part of the latter. Under these conditions, it will be understood that the take-off roll 13 will be located above the web so as to effect a correct return thereof, and, moreover, means for tensioning this web have been provided, which are constituted by a tensioning system 11 formed by a roll 16 mounted to rotate at the end of an articulated connecting rod 17 about an axis O and which is in abutment on the web 2. This system 11 is able to perform several functions. Firstly, it makes it possible to maintain a virtually constant tension of the loop 8 despite the accelerations imposed on the web 2 during the operations. Secondly, it makes it possible to absorb the small shifts in length

which may affect the loop 8 during successive cut-out cycles. Finally, it makes it possible to detect in simple manner, particularly by measuring the inclination taken by the connecting rod 17, the moment when the accumulated drifts of these shifts attain a critical threshold. Once this detection is effected, servo-control means may then intervene, particularly at the level of the feed roll 5, in order to ensure a compensation in length of the loop 8 having the effect of returning the connecting rod 17 of the tensioning system 11 to its normal operational position.

Of course, such a regulation can be ensured by mechanisms other than such systems and in particular by strain gauges which might be disposed on the shafts of a guide roll.

In order to facilitate correct synchronism of the web 2 with the cut-out roll 3 and its counterpart roll 3', a cyclic mark may be made on the web 2, which will be synchronized with a determined angular position of the cut-out plates. In this way, at each of the cycles of rotation of the cut-out rolls 3, a comparison between the position of this mark and the position of the cut-out plates 3b will be made. If an error in positioning is detected, it will provoke, via servo-control means, a reaction of the take-off roll 13 which will effect a correction of repositioning of the web 2.

The machine according to the invention may also be carried out in configurations in which the speed of feed V_e of the web 2 and/or the speed of rotation V_c of the shaping rolls are not constant.

It is thus ascertained in Figure 4a that, during the first phase, or cut-out phase, the peripheral speed V_c of the cut-out rolls 3 and the speed of feed V_n of the web 2 at these cut-out rolls which is ensured by the take-off roll 13, are equal, which is, of course, necessary for a correct cut-out operation. It is also ascertained in this Figure that the speed of feed V_e is different and constant, and

thus remains so not only during the cut-out phase but also during the end-of-cycle phase.

During the latter, which begins when the cut-out rolls 3 are in the position shown in Figure 2a, it is ascertained that the speed V_n of the web 2 decreases regularly, reverses, remains constant during a short fraction of time, then re-accelerates in the normal direction, to attain a speed $V_n=V_c$ when the following cut-out phase will begin, as shown in Figure 2b.

Figure 4b shows, during the two phases previously taken into account, namely the cut-out phase and the end-of-cycle phase, the linear positioning of the different elements. It is thus ascertained that, during the first phase, or cut-out phase, the linear positioning of the web and that of the periphery of the cut-out plate, are identical, which is of course necessary for the quality of the cut-out. It is then ascertained that, during the second phase, or end-of-cycle phase, the inclination of the straight line (speed) expressing X_c, i.e. the positioning of the points of the plate, remains constant and that, inversely, the curve expressing X_n varies, the inclination of this curve decreasing in order then to increase, and it is also ascertained that, at the end of end-of-cycle phase, the advance of the web at the entry is equal to the advance of the web at the exit, this bėing expressed by point A in Figure 4b. It is also ascertained that, at that point A, the tangent zz' to the curve X_n is parallel to the curve X_c, which shows that, at the start of a new cycle, the speed of the web which enters in the cut-out rolls 3 is equal to the peripheral speed of the latter.

The apparatus according to the invention also makes it possible to effect shaping of webs in which the entry speed V_e is variable in accordance with a well-determined specific law of variation which is a function of the type of work effected. Figure 5 thus shows the operational parameters of the apparatus, concerning the positioning X_c of the cut-out plates, of the web upstream of the

cut-out rolls X_n (curve in broken lines), of the web at the level of its feed X_e and from which the positioning of the guide roll 9 X_t has been deduced.

The present form of embodiment makes it possible to place in the same machine, and successively, two shaping apparatus of the same period presenting a phase shift therebetween. Figure 6 thus shows an apparatus P_1 of which it is seen that the cut-out plates are located at the beginning of cut-out phase, and a second apparatus P_2 located upstream of the apparatus P_1 and of which it is seen that the cut-out rolls present a phase shift α with respect to the cut-out roll of the apparatus P_1. Thanks to the regulating module 7, the present invention makes it possible to compensate the phase shift of these two apparatus of the same period.

The present invention also enables machines to be made, comprising apparatus of different periods and, in addition, presenting a phase shift.

The present invention also makes it possible to compensate variations in the peripheral speed V_c of the shaping rolls in the course of the same shaping cycle, which variations make it possible for example to minimize the accelerations of the web (by the reduction of V_c), by giving the latter more time to effect its to and fro movement. In the event of the plate 3b being of short length, it also makes it possible to increase this time the peripheral speed V_c during the end-of-cycle phase, this making it possible to reduce the duration of the total cycle.

The present invention may, of course, be used with shaping means other than cut-out means and might advantageously be applied to fold-marking means, embossing means, stamping means, etc...

The displacement of the guide element 9 may be other than linear, and in particular be circular. As schematically shown in the form of embodiment of Figure 7, the guide roll 9 is mounted on a support sub-assembly 20, particularly

constituted by two plates 21 connected in their upper part by a beam 23, this support being mounted to move in rotation about a shaft 22. This shaft 22 also constitutes the support of a regulating roll 24 which is tangential to the guide roll 9. The web 2 is brought by the feed roll 5, abuts on the regulating roll 24 in order then to be admitted between the latter and the guide roll 9 around which it winds in order finally to go towards the take-off roll 13, between which and its counterpart roll 13' it is admitted. It will be understood that, when the support 20 pivots about the shaft 22, so that the shaft 25 of the guide roll 9 follows the broken line C, the length of the loop 8 increases or decreases depending on the direction of this rotation. In order to minimize the friction between the web and the rolls 9 and 24, these two rolls may be provided with means such as gears ensuring their connection in rotation. The law of displacement and of speed of the guide roll 9 will then be determined in accordance with the arc of circle C.

The arrangement shown in Figure 7 may be simplified mechanically by attributing several functions to certain of the rolls. Figure 10 shows such an example of embodiment in which the regulating roll 24 has been replaced by the take-off roll 13. The counterpart roll 13' thereof is disposed above the latter. In this configuration, it is understood that the roll 13 performs two functions here, namely its function of take-off, as defined in the preceding forms of embodiment, and the function performed previously by the regulating roll 24. As in the form of embodiment shown in Figure 7, the regulating/take-off roll 13 and the guide roll 9 are disposed on a support 20 adapted to pivot about the shaft 22 merged with the axis of rotation of the regulating/take-off roll 13. As previously, when the support 20 pivots about shaft 22, so that the shaft 25 of the guide roll 9 follows the broken line C, the length of the loop 8 increases or decreases depending on the direction of this rotation.

In the variant embodiment shown in Figure 8, it is arranged that the sub-assembly 20, besides its function of controlling accumulation of the web 2, performs, in addition, a second function, namely that performed previously by the take-off roll 13 and its counterpart roll 13', namely to ensure control of the web upstream of the shaping roll 3. Such control will thus be obtained by a more or less great oscillation.

According to the invention, it might also be possible to use the guide roll 9 as take-off roll instead and in place of the rolls 13 and 13'. In such a modus operandi, it is the guide roll 9 which performs the function of control of positioning X_n and of speed V_n of the web 2 previously performed by the rolls 13 and 13'. In this modus operandi, the rolls 13 and 13' are in that case animated by a speed of rotation giving them an overspeed with respect to the web 2, with the result that they permanently slip thereon.